

September 20, 2001

MEMORANDUM FOR: Richard S. Cohen
National Geodetic Survey State Geodetic
Advisor

FROM: Charles W. Challstrom
Director, National Geodetic Survey

SUBJECT: INSTRUCTIONS: COLORADO CRUSTAL MOTION GPS
SURVEY, 2001 (GPS-1612)
Task Number: 8K6D20

GENERAL:

The National Geodetic Survey (NGS), will partner with the University of Colorado in their effort to establish a GPS base network for calibrating seismic hazard in the Front Range and the Rio Grande Rift.

The University of Colorado will observe four stations continuously for the duration of the survey, approximately 30 days (CTCORS). In addition, the University of Colorado will observe approximately 22 stations for 36-hour occupations. Other agencies will also participate and will observe stations for three 5-1/2 hour sessions. The Colorado Department of Transportation may also participate in the survey.

State Advisors in the surrounding states will make the border ties; doing one 5-1/2 hour session for each nearby FBN station.

The contact for the project is Dr. Frederick Blume, University of Colorado. The project coordinator is Mr. Richard Cohen, NGS State Geodetic Advisor for Colorado.

SPECIFICATIONS:

Project requirements for the observations are to ensure 2-centimeter local accuracy in the horizontal component, as well as 2-centimeter local accuracy for the ellipsoid heights.

N/NGS21:SJFrakes:301-713-3194:amg:09-13-01
A:\COLORADO

Data from thirteen National CORS and one NGS Cooperative CORS in the region are to be used in the processing. Five of the National CORS are in Colorado; two National CORS each are in Wyoming, Utah, New Mexico, and Nebraska. The Cooperative CORS is also in Colorado.

The five National CORS in Colorado are: Colorado Springs (AMC2), Table Mountain (TMGO), Platteville (PLTC), Boulder (DSRC), and Granada (GDAC). The two National CORS in Wyoming are Boulder (BLWY) and Medicine Bow (MBWW). Red Butte (RBUT) and Price (PUC1) are the two National CORS in Utah. Aztec (AZCN) and Tucumcari (TCUN) are the two National CORS in New Mexico. The two National CORS in Nebraska are McCook (RWDN) and Whitney (WHN1). The NGS Cooperative CORS is MC01 and is located in Grand Junction.

Positions and data for the National and Cooperative CORS are available from the NGS web site.

The observing scheme shall be arranged to ensure that adjacent stations are directly connected in at least one observing session, and at least half of all base lines are repeated. The CORS base lines will be repeated. CORS and CTCORS data will be used throughout the project.

For stations that are being occupied with three 5-1/2 hour sessions, the start time of one of the sessions must be staggered by at least 4 hours from the other two. In this regard, two observing windows have been selected - 1500 UTC and 1900 UTC.

In general, station occupation and observing procedures must be carried out according to appropriate sections of the "NGS Operations handbook" and the current applicable receiver field manuals. Data formats and digital file definitions are given in "Input Formats and Specifications of the National Geodetic Survey data Base," Volume I. Horizontal Control Data, Federal Geodetic Control Subcommittee, September 1994, revised and reprinted November 1998. Success in meeting the accuracy standards will be based on repeatability of measurements and adjustment residuals.

General specifications for the project are given in "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0: dated May 11, 1988, reprinted with corrections August 1, 1989. Specific

project criteria and deviations from the general specifications are given in the following sections.

Project Network - A list (Table 1) and sketch of stations involved in this project will be provided.

Data Acquisition - Data collection must be accomplished as specified in the appropriate dual-frequency receiver field manuals in the compressed mode at a 15-second epoch collection interval. The GPS receivers must be dual-frequency and full-wavelength. Track satellites down to a 10-degree elevation angle.

Record weather data just before, immediately after, and at the midpoint of each session. Meteorological data shall also be collected immediately after an obvious weather front passes during a session and immediately before it passes, if possible. Pressure and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Indicate in the log the location of the barometer and psychrometer.

Survey Operations shall be conducted with due regard to the safety of personnel and equipment.

Vector Computations - Data management, quality review of collected data, and final vector processing for the survey will be accomplished using PAGES. Vectors shall be computed in the International Earth Rotation Service Terrestrial Reference Frame (ITRF) system, using the most current epoch and precise IGS ephemerides. Use 30-second epoch intervals for data processing. Monument positions will be used for CORS when available, otherwise, antenna reference point (ARP) positions will be used. Mr. Rick Foote, N/NGS22, will be responsible for the processing.

The data will be processed in 24-hour sessions (or slightly longer if the observation session crosses 0000 UTC) in order to utilize the 24-hour data sets collected at the CORS and CTCORS. The "fixed baseline" option in PAGES will be used to compute direct baselines between the CORS. The "fixed baseline" scheme will depend on the location and reliability of the CORS and CTCORS used in this project.

For stations where weather data are not available, or are suspect, predicted values computed in PAGES based on the station's latitude, height above mean sea level, and time and day of year will be used. Use 15 degrees as the cutoff elevation angle in data processing. A cutoff angle of 10 degrees may be used when necessary to improve results.

The type of final solution, L1 versus ion-free, will depend on the length of the vectors. For vectors which are less than 10 km in length, the final reduction will consist of a L1 fixed solution. These vectors will be computed in a separate processing session from the longer vectors computed in an ion-free solution.

In general, vectors greater than 10 km in length are to be computed in an ion-free fixed, or partially-fixed, solution. In all cases, integer ambiguities will be fixed for each vector whenever possible.

The quality of collected data shall be determined from the plots generated from PAGES, by analysis of repeated vectors and/or comparison of station positions, and free adjustment residuals and/or loop misclosures. In addition, a constrained adjustment constraining the CORS will be performed.

Rick Foote will perform all quality checks for conformance with NGS format standards such as executing software programs COMPGB, OBSCHK, and OBSDES. The final ITRF vectors will be assessed and transformed to the NAD 83 coordinate system using program ADJUST.

The data and results will be submitted to the Observation and Analysis Division. All B-files and G-files must be complete, including *25* and *27* records.

The University of Colorado will do independent data reductions for the crustal motion study.

Station Descriptions - Station recovery notes must be submitted in computer-readable form using WDDPROC software. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include the telephone numbers of private property owners. Richard Cohen will be responsible for the station descriptions.

Special Requirements - Antenna set-up is critical to the success of this project. Fixed-height tripods are preferred for all receivers. The plumbing bubbles on the antenna pole of the fixed-height tripod must be shaded when plumbing is performed. They must be shaded for 3 minutes before checking and/or re-plumbing. Also, the perpendicularity of the poles must be checked at the beginning of the project and any other time there is suspicion of a problem. In addition, the heights of the fixed-height poles must be measured at the beginning of the project.

When a fixed-height tripod is not used, the height of the antenna must be carefully measured to prevent station set-up blunders from occurring. Tribrachs used for these set-ups must be checked and adjusted when necessary. Totally independent measurements of the antenna height above the mark in both metric and English units must be made before and after each session. Someone other than the observer must check the measurement computations by carefully comparing measurements and then entering his/her initials on the log.

Some GPS antennas have detachable ground planes and radomes. In order to help identify what exactly was used at a particular site, it would be useful to have a snapshot of the setup. All observers should take a photograph of the setup, if possible, with a close-up of the antenna as viewed from the side.

In addition, digital photographs of each survey mark are required. See "Requirements for Digital Photographs of Survey Marks & CORS Antennas," Version 5, for specific information.

Also, a rubbing of the stamping of the mark must be made at each visit to a station. If it is impossible to make a rubbing of the mark, a plan sketch of the mark must be substituted, accurately recording all markings.

Also, for each station visited, a visibility obstruction diagram must be prepared and the TO-REACH description carefully checked for errors or omissions.

Lastly, the following must be recorded at each occupation of a station:

- (1) receiver manufacturer,
- (2) antenna manufacturer,
- (3) receiver model number (part number),
- (4) antenna model number (part number),
- (5) the complete serial number of the receiver, and
- (6) the complete serial number of the antenna.

Success of this project requires that the highest quality GPS data be collected. Therefore, during each station occupation, the operators shall carefully monitor the operation of the receivers. Any irregularities in the data due to equipment malfunction, DOD adjustment of the satellite orbit, obstructions, etc., must be reported to the Project Development Branch, N/NGS21, as soon as possible and noted on the observing log. If the quality of observations for an observing session is questionable, notify the Project Development Branch immediately.

The survey team shall not depart the project area until they have quality reviewed all data and advised N/NGS21.

GPS DATA:

Visibility tables and plots of the present satellite constellation for August 12, 2001, have been reviewed and two observing windows selected. For operational use, current data must be generated with Trimble mission planning software or from program SATMAP.

A project report and the data listed in Annex L of "Input Formats and Specifications of the NGS Data Base" and in the attached addendum for the adjustment portion of the project must be transmitted. Any data considered suspect as to quality in achieving accuracy standards should be sent via FedEx immediately for office review. Backup of transmitted data must be held until notified by the Project Development Branch, N/NGS21.

The data set collected during the project shall be named "cocm081d.876". All records in connection with this project shall be titled "COLORADO CRUSTAL MOTION GPS SURVEY, 2001". The project number (accession number) is GPS-1612.

LIAISON:

Liaison must be maintained with designated offices at the National Geodetic Survey headquarters located at:

1315 East-West Highway
Silver Spring, Maryland 20910-3282

Questions and problems concerning adjustment processing should be directed to:

Maralyn L. Vorhauer
Observation and Analysis Division
N/NGS4, SSMC III, Station 8562
Telephone: 301-713-3176, ext. 104
Fax: 301-713-4327
e-Mail: maralyn@noaa.gov

Questions and problems concerning vector processing should be directed to:

Juliana Blackwell
Field Operations Branch
Observation and Analysis Division
N/NGS41, SSMC III, Station 8458
Telephone: 301-713-3215, ext. 108
Fax: 301-713-4327
e-Mail: Juliana.Blackwell@noaa.gov

Questions and problems concerning using CORS data in processing should be directed to:

Neil Weston
Geosciences Research Division
N/NGS6, SSMC III, Station 9830
Telephone: 301-713-2847, ext. 202
Fax: 301-713-4475
e-Mail: Neil.Weston@noaa.gov

Questions and problems which could affect the technical adequacy of the project should be directed to:

Stephen J. Frakes (Douglas R. Hendrickson)
Chief, Project Development Branch
Spatial Reference System Division

N/NGS21, SSMC III, Station 8853
Telephone: 301-713-3194, ext. 111 (ext. 127)
Fax: 301-713-4316
e-Mail: steve@ngs.noaa.gov (dough@ngs.noaa.gov)

The contact for the project is:

Dr. Frederick Blume
Department of Geological Sciences
University of Colorado
Boulder, Colorado 80309-0399
Telephone: 303-579-9952
e-Mail: blume@kangra.colorado.edu

The coordinator for the project is the NGS State Geodetic
Advisor for Colorado:

Richard Cohen, NOAA RC
325 Broadway
Boulder, Colorado 80303
Telephone: 303-758-9197
e-Mail: fossilgps@aol.com

Names and telephone numbers of local contacts are given in the
station description material.

ADDRESS:

Keep N/NGS21 informed of the party's physical address and
telephone number at all times.

PUBLICITY:

See "NGS Operations Handbook," Section 1.4.1.

EXPENSES:

Expenses for this project will be charged to task number
8K6D2000.

TRAVEL:

Travel and per diem are authorized in accordance with Federal
Travel Regulations, Part 301-11, Per Diem Allowances. Current
per diem rates were effective October 1, 2000.

ACKNOWLEDGMENT:

Please acknowledge receipt of these instructions in your Monthly Report.

cc: N/NGS - D. Zilkoski*
N/NGS - S. Misenheimer*
N/NGS1 - G. Mitchell
N/NGS1x1 - R. Cohen
N/NGS11 - S. Cofer
N/NGS21 - S. Frakes
N/NGS21 - R. Anderson
N/NGS21 - D. Hendrickson*
N/NGS22 - T. Soler
N/NGS22 - R. Foote
N/NGS3 - J. Bailey
N/NGS4 - E. Wade
N/NGS4 - M. Vorhauer
N/NGS4 - D. Hoar
N/NGS41 - W. McLemore
N/NGS41 - J. Blackwell
N/NGS5 - R. Snay
N/NGS6 - N. Weston
FGCS Members*
Fred Blume, University of Colorado

* first page only

**DATA TO BE SENT TO HEADQUARTERS RELATING TO
THE ADJUSTMENT PORTION OF
FBN/CBN PROJECTS**

Free adjustment in NAD 83 (UNIX run).

Plots of the free adjustment created by running "plotres_prompt.bsh" on a UNIX server. Plots require a printer that supports postscript. The output file (long.out) contains a list of residuals which may be sorted using the following commands:

```
vi long.out
:1,$ !sort +0.47 (sorts horizontal residuals)
:1,$ !sort +0.71 (sorts vertical residuals)
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(OPTIONAL) Constrained horizontal adjustment holding NGS CORS positions and ellipsoid heights.

Final combined Blue Book file (ASCII required) with *86* records (GEOID99).

Final description file (ASCII required.)

Final G-file (ASCII required.)

OBSCHK output.*

CHKDDESC output.*

OBSDES output.*

*Any errors or warning messages must be explained.